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# Automated energy meter

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**Abstract**

In recent years, the Smart Energy Meter has attracted a lot of attention from all over the world. In this paper a design and prototyping a low-cost IoT energy monitoring is presented, which may be utilized in a variety of applications such as power billing, smart grid energy management, and home automation. The system is based on a low-cost ESP32 microcontroller that is interfaced non-invasive Current Sensors, and Voltage Sensor to get data from sensor nodes and deliver it to a Blynk server over the internet. The studies' findings showed that the system for monitoring energy consumption can precisely record voltage, current, active power, and cumulative power consumption. According to the market requirements of Electric Meters. Nowadays, the system will use ZigBee and GSM systems for communication protocol. The ZigBee is used since the application does not need a high-speed data rate, need to be low powered and low-cost. Presenting the remote wireless Electric Meter Reading System, aims at resolving the shortcomings of the technology of the traditional Electric Meter Reading, combining the characteristics of the ZigBee technology and IEEE802.15.4 standard. Electricity is one of the fundamental necessities of human beings, which is commonly used for domestic, industrial, and agricultural purposes. Power theft is the biggest problem in recent days which causes a lot of loss to electricity boards. In countries like India, these situations are more often. If we can prevent these thefts, we can save a lot of power. This is done using Automated Energy Meter (AEM). AEM is an electronic device with having energy meter for measuring the electric energy consumed and a wireless protocol for data communication

## 1. Introduction

Automatic Energy Meter reading is a process of reading the energy consumption meter reading and processing that data automatically with computers. This process of automatic meter reading and communication via technologies will improve the efficiency of energy meter reading process and billing of the same. This will also eliminates the tedious work done by a labour physically attending every energy meter and using the data to make the bill for the owner. Automated energy meter will be faster and error free. Zigbee is one of the promising solution for low data rate , low power consumption, secure and reliable wireless communication protocol and hence it is chosen as lower layer communication protocol. With the rapid development in the field of Automation, developing an Automated Energy Meter(AEM) reading is the need of hour. With Machine Learning, Artificial intelligence, Internet Of Things automation becomes simpler. AEM will also make billing process of Energy consumption transparent and fair. Electric energy use has surged in recent years. As a result, a large increase in energy supply was required. due to population growth and other factors in the coming decades development of the economy as a result, there is a demand-supply imbalance. According to the current scenario, the power generated, which is mostly derived from fossil fuels, will be depleted within the next 20 years. Electronic energy monitoring solutions are currently available on the market that are extremely accurate. In the case of residential 2 applications, the majority of these monitor the power utilized in a domestic household. Consumers are frequently disappointed with their power bills since they do not display the power used at the device level. The Internet of Things (IoT) offers a solution to these issues. Hardware, software, and the cloud are all interconnected. As a result, we offer an energy consumption model. Household appliance monitoring system that can be used to calculate energy consumption of the family and to keep the user up to date on his or her electricity usage and be able to make informed decisions. With the advent of Internet of Things (IoT) technology, an existing energy meter with an industrial communication protocol can be adapted to improve connection and observability of power and energy consumption. This can be accomplished by utilizing IoT technology. As a result, this study presents an approach that incorporates IoT technology so that current digital energy meters in buildings can be modified to enable for online monitoring.

## 2. Architecture

### 2.1 Proposed model

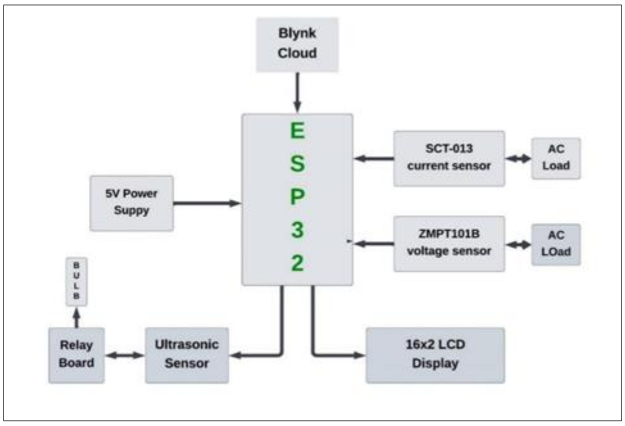


**Figure 1** Proposed Model

## 3. Literature survey

Kumar L developed an IoT-based smart energy meter using the Atmega328P microcontroller, voltage sensor, current sensor, ESP8266 Wi-Fi chip, and SIM900 GSM module. The system sends energy consumption data to the Thing Speak cloud platform through the internet. In case of cloud connectivity issues, a 4G GSM module transmits data as an SMS. Fast Fourier Transform is employed to calculate energy consumption and its associated cost.

Waghmare M proposed a versatile energy metering system suitable for both industrial and residential settings. The system consists of sensor nodes, a gateway, and a server. Sensor nodes collect data on power consumption, power line parameters, and environmental variables. The data is transmitted to an Android HTTP gateway running on a Raspberry Pi 3, which then sends it to a central server for analysis.Pratik M designed an energy monitoring system utilizing the NodeMCU with an ESP8266 Wi-Fi chip and a GSM module. This system provides daily power consumption information and manages electrical appliances for energy savings. Additionally, it facilitates communication between the electricity board and consumers, allowing for bill notifications, payment reminders, and scheduled outages

Visvanatha S developed a system based on the Atmega328P microcontroller for power theft detection and control. The system employs relay logic to connect and disconnect the energy meter from utility devices. A GSM module enables automatic SMS notifications to the consumer and the central authority server in the event of faults or anomalies.

Anirudh Kumar proposed an autonomous meter reading system utilizing a Light Dependent Resistor (LDR) for energy usage monitoring. This tamper-proof system ensures data integrity and connects energy usage to specific frequencies recorded on a memory card. The data is then transmitted to a server using HTTP and the ESP8266 module.To minimize human intervention, a Bluetooth-enabled energy meter was proposed, incorporating automatic meter reading and polling mechanisms. A CSR Bluetooth Blue EZ module and an Analog Devices ADE7756 energy meter are used to develop a cost-effective and reliable solution. However, the limited range of Bluetooth restricts its suitability for long-distance communication. Kaur M presented an energy consumption monitoring system based on Arduino-Uno and Ethernet. Users can access energy information through an IP address on their devices. However, this system incurs a higher initial installation cost. Another Automatic Meter Reading system eliminates the need for replacing existing analog energy meters by employing an external module and a WiMAX transceiver for data transmission.

## 4. Methodology

- Hardware Setup
  - Connect the voltage sensor and current sensor to measure the voltage and current values of the power supply.
  - Connect the LCD display to provide a visual output for energy consumption information.
  - Connect the I2C interface to enable communication between the various components.
  - Connect the ultrasonic sensor to detect the presence of users or objects near the energy meter.
  - Connect the relay board to control the power supply to the meter or connected devices.
  - Connect the Node-MCU board to facilitate data transmission and communication with other devices.
- Sensor Calibration:
  - Calibrate the voltage sensor and current sensor to ensure accurate measurement of voltage and current values.
  - Configure the ultrasonic sensor to detect the presence of users or objects within a specific range.
- Data Acquisition:
  - Read the voltage and current values from the respective sensors connected to the energy meter.
  - Use appropriate analog-to-digital conversion techniques to convert the sensor readings into digital values.
  - Store the acquired data in the memory of the Node-MCU or external storage device.
- Energy Calculation:
  - Utilize the acquired voltage and current values to calculate the real-time power consumption.
  - Implement algorithms or formulas to calculate the energy consumed over a specific time period.
  - Calculate the associated cost of energy consumption based on predefined rates.
- Display and User Interface:
  - Use the LCD display to provide real-time energy consumption information to the users.
  - Implement user-friendly menus and options to navigate through different functionalities of the energy meter.
- Control and Automation:
  - Incorporate the ultrasonic sensor data to detect the presence of users or objects.
  - Use the relay board to control the power supply to the energy meter or connected devices based on user presence or pre-defined schedules.
- Communication and Connectivity:
  - Configure the Node-MCU to connect to the local Wi-Fi network or utilize GSM modules for cellular connectivity.
  - Establish a connection to the internet and enable data transmission to remote servers or cloud platforms.
  - Implement secure protocols to ensure the privacy and integrity of the transmitted data.
- Data Logging and Analysis:
  - Implement a data logging mechanism to store energy consumption data over extended periods.
  - Utilize data analysis techniques to generate insights and trends regarding energy consumption patterns.
- User Notifications and Alerts:
  - Implement a notification system to alert users about energy consumption, costs, and abnormal usage patterns.
  - Send notifications or alerts through SMS, email, or mobile applications.
- System Testing and Calibration:
  - Perform thorough testing of the automated energy meter system to ensure accurate measurements, proper functionality, and reliability.
  - Calibrate the sensors periodically to maintain measurement accuracy.
- Deployment and Maintenance:
  - Install the automated energy meter in the desired location, following electrical safety guidelines.
  - Regularly monitor the system for any anomalies or malfunctions, and perform necessary maintenance or updates as required.

### 4.1 Circuit Diagram

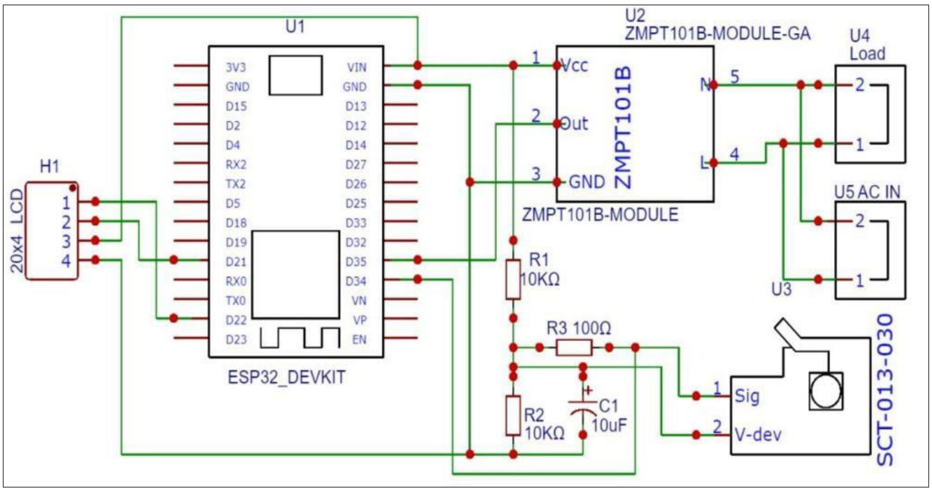


**Figure 2** Circuit Diagram

## 5. Result

In this section, the operation of the ESP32 electric energy consumption meter is described. Figure 3 illustrates the user-interface dashboard, which represents the web dashboard of the sensor node used as an example. To create the dashboards, the Blynk app was utilized. The dashboard consists of various gauges that provide real-time information on the RMS voltage, current, power consumption, and total energy consumed. Additionally, a 16x2 LCD display is employed to visualize the changes in measured energy data over time. The energy sensor prototype successfully collected the sensor data, which was then transferred to the Blynk server for further analysis and monitoring. This comprehensive system enables users to conveniently track and manage their energy usage through intuitive and informative dashboards.


**Figure 3** Mobile View


**Figure 4** Readings on LCD display

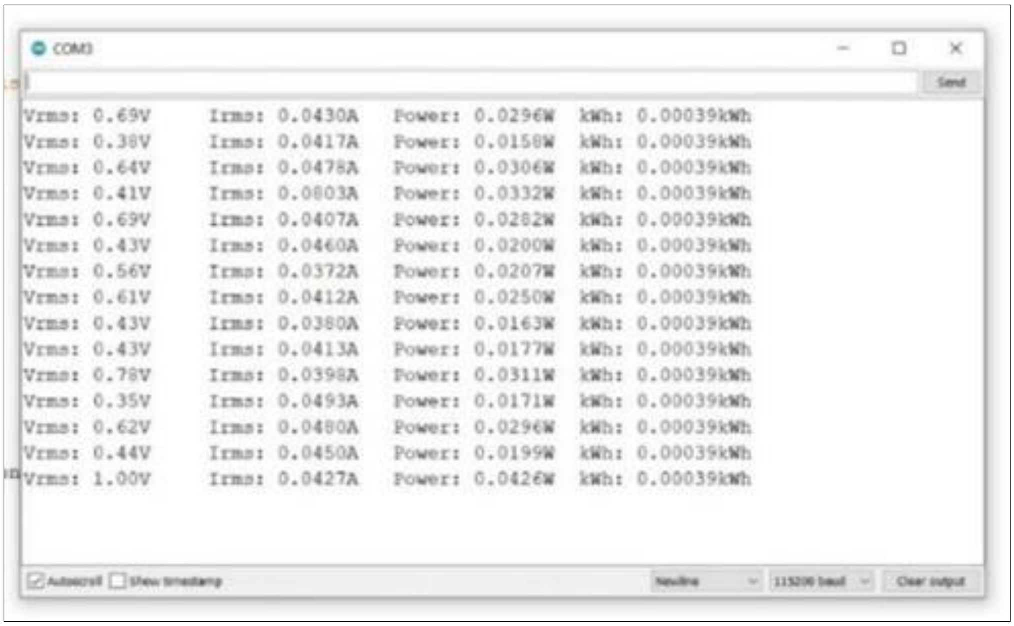


**Figure 5** Serial Monitor View

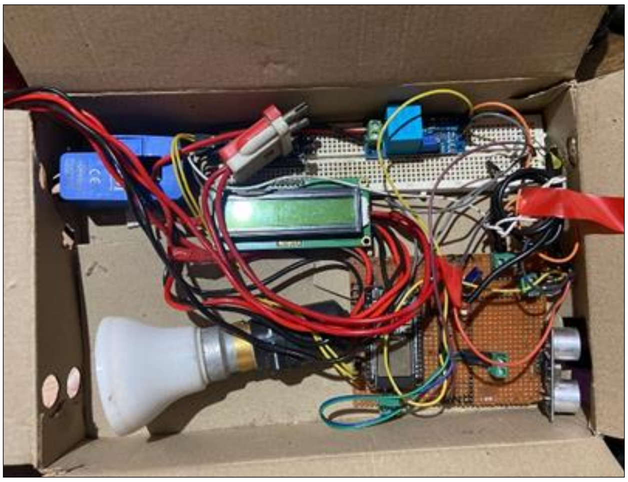

**Figure 6** Hardware Model

## 6. Conclusion

The development of a IoT Based Smart Electricity Energy Meter using ESP32 and Blynk 2.0 will bring about a revolution in the monitoring and measurement of electricity consumption. The IoT-based solution eliminates manual meter readings, saving time and money. With the use of the best current and voltage sensors, accurate readings of voltage, current, power, and total energy consumed can be obtained. The data can be accessed from any location through the Blynk 2.0 dashboard. In case of power outages, the energy meter data is stored in ESP32's EEPROM, ensuring continuous readings. The results of the experiments revealed that the designed energy monitoring system can successfully monitor voltage, current, active power, and temperature. electricity consumption over time. This work could be improved in future research discover more about the energy usage profile and how to detects which appliance is in use automatically using machine learning techniques.

## Compliance of ethical standard

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### *Disclosure of conflict of interest*

AEM will reduce the man power required for the tedious work but at the same time it is not in the interest of the un employment crisis in the developing countries.

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